EL 897959449US

JC10 Rec'd PCT/PTO 1 8 MAR 2002

FORM PTO-1390 (REV. 12-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY 'S DOCKET NUMBER: 102031-201

U S. APPLICATION NO. (If known, see 37 CFR 1.5): 10/088409

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/US00/25866	21 September 2000	21 September 1999

TITLE OF INVENTION: INDUSTRIAL AMMUNITION

APPLICANT(S) FOR DO/EO/US: OLIN CORPORATION

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [XX] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [XX] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [X] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [XX] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [ ] has been communicated by the International Bureau.
   c. [XX] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [ ] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [XX] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [XX] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [XX] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [XX] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [XX] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [XX] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [ ] Other items or information:

JC10 Rec'd PCT/PTO 13 MAR 2002

U.S. APPLICATION NO (if known, see 37 CFR 1.5) 10/088409	INTERNATIONAL APPLICATION NO PCT/US00/25866	ATTORNEY'S DOCKET NUMBER 102031-201

21. ☒ The following fees are submitted:	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$710.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$	
Total claims	32 - 20 =	12	x **$18.00**	$ 216.00	
Independent claims	7 - 3 =	4	x **$84.00**	$336.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$280.00**	$	
TOTAL OF ABOVE CALCULATIONS =				$1262.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. +				$	
SUBTOTAL =				$1262.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$	
TOTAL NATIONAL FEE =				$1262.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$40.00	
TOTAL FEES ENCLOSED =				$1302.00	
				Amount to be refunded:	$
				charged:	$

a. ☐ A check in the amount of $ _____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 23-1665 in the amount of $ 1,302.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any deficiencies or overpayment to Deposit Account No. 23-1665 . A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

27267
PATENT TRADEMARK OFFICE

SIGNATURE

William B. Slate
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37,238
REGISTRATION NUMBER

Express Mail No. EL 897959449 US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Douglas D. Olson, et al.	Docket No.:	102031-201
Serial No.:	U.S. National Phase of PCT/US00/25866	Art Unit:	N/A
Filed:	September 21, 2000	Examiner:	N/A
Assignee:	Olin Corporation		
Title:	Industrial Ammunition		

Box PCT
Commissioner for Patents
Washington, DC 20231

NATIONAL STAGE PRELIMINARY AMENDMENT

Dear Sir:

In the Specification:

Please amend the first paragraph of the application presently spanning lines 6-8 of page 1 of the specification to read as follows:

This is the U.S. National Stage of PCT/US00/25866, entitled "INDUSTRIAL AMMUNITION" filed September 21, 2000 and published in English on March 29, 2001 as WO 01/22026 and claims priority to U.S. Provisional Patent Application 60/155,052, entitled "INDUSTRIAL AMMUNITION AND METHOD AND APPARATUS FOR USE THEREOF" filed September 21, 1999.

In the Claims:

Please cancel claims 1-21 without prejudice or disclaimer.

Please add new claims 34-53 as follows:

34. (New) Ammunition in combination with a discharging apparatus for firing such ammunition wherein:

the discharging apparatus comprises:

a chamber for receiving the ammunition;

a muzzle; and

a barrel between the chamber and the muzzle; and

the ammunition extends from a rear end to a front end and comprises:

a metallic case that:

extends aft-to-fore from a base at the ammunition rear end to a mouth;

has interior and exterior surfaces;

has a central longitudinal channel extending forward from a primer pocket portion at the base to a fore portion proximate the mouth; and

has a length and diameter effective to be initially accommodated within the chamber and then, after firing, to be driven forward into the barrel and discharged therefrom by such firing of a subsequent similar ammunition;

a cover formed of polymeric resin and extending from a rear rim to a front end at the ammunition front end and having a mass not in excess of a mass of the case and having interior and exterior surfaces;

a primer mounted within the primer pocket; and

a propellant charge confined within a volume at least partially defined by the central longitudinal channel and the cover interior surface.

35. (New) Ammunition in combination with a discharging apparatus for firing such ammunition wherein:

the discharging apparatus comprises:

a chamber for receiving the ammunition;

a muzzle; and

a barrel between the chamber and the muzzle; and

the ammunition extends from a rear end to a front end and comprises:

a metallic case that extends aft-to-fore from a base at the ammunition rear end to a mouth and has interior and exterior surfaces, the metallic case having a case length and diameter effective to be initially accommodated within the chamber and then, after firing,

to be driven forward into the barrel and discharged therefrom by such firing of a subsequent similar ammunition;

a cover formed of polymeric resin and extending from a rear rim to a front end at the ammunition front end and having a cover length greater than the case length having a mass not in excess of a mass of the case and having interior and exterior surfaces; and

a propellant charge confined within a volume at least partially defined by a combination of said case and said cover.

36. (New) The combination of claim 35 wherein:

the cover consists essentially of injection molded high density polyethylene; and

the case consists essentially of die cast zinc or zinc alloy.

37. (New) Ammunition in combination with a discharging apparatus for firing such ammunition wherein:

the discharging apparatus comprises:

a chamber for receiving the ammunition;

a muzzle; and

a barrel between the chamber and the muzzle; and

the ammunition extends from a rear end to a front end and comprises:

a metallic case that extends aft-to-fore from a base at the ammunition rear end to a mouth and has interior and exterior surfaces, the metallic case having a length and diameter effective to be initially accommodated within the chamber and then, after firing, to be driven forward into the barrel and discharged therefrom by such firing of a subsequent similar ammunition;

a cover formed of polymeric resin and extending from a rear rim to a front end at the ammunition front end and having a mass not in excess of a mass of the case and having interior and exterior surfaces, the cover interior surface having a circumferential recess forward of the case and effective to locally weaken the cover sufficiently to permit internal pressure within the cover to sever a portion ahead of the recess from a portion behind the recess while the portion behind remains attached to the case when the ammunition is fired; and

a propellant charge confined within a volume at least partially defined by a combination of said case and said cover.

38. (New) The combination of claim 37 wherein the circumferential recess:

has a longitudinal extent of between 1mm and 5mm; and

locally thins the cover to a minimum thickness of between 0.6mm and 1.4mm from an adjacent thickness of between 1.6mm and 2.6mm.

39. (New) Ammunition for use with a discharging apparatus that includes a chamber for receiving the ammunition, a muzzle and a barrel between the chamber and the muzzle, the ammunition comprising:

a case formed of a cast zinc or a cast zinc-based alloy that extends aft-to-fore from a base to a mouth and has interior and exterior surfaces;

a propellant charge contained within the case;

a primer mounted in the case; and

a member cooperating with the case to enclose the propellant charge, said ammunition lacking a projectile having a mass in excess of a mass of the case.

40. (New) The ammunition of claim 39 wherein:

the primer is a #209 primer; and

the case has a mass of between 70g and 100g and a maximum diameter of between 20mm and 26mm.

41. (New) The ammunition of claim 39 wherein the member is a cap extending from a rear rim to a front end and having a rear portion encircling a fore portion of the case.

42. (New) The ammunition of claim 41 wherein:

the cap is formed of a resinous polymer;

the case fore portion includes a flange having an external flange diameter;

the cap rear portion includes an inwardly directed part aft of the flange and having an internal diameter less than the flange diameter so as to cooperate with the flange to resist forward translation of the cap relative to the flange; and

a cap length is between 100% and 300% of a case length.

43. (New) In an ammunition round for use with a discharging apparatus that includes a chamber for receiving the ammunition, a muzzle and a barrel between the chamber and the muzzle, the ammunition of the type wherein the case of one round fired by the apparatus serves as a

projectile expelled by ignition of the propellant charge contained within the case of the next round, the improvement wherein:

the case is formed of a cast zinc or a cast zinc-based alloy that extends aft-to-fore from a base to a mouth and has interior and exterior surfaces;

the primer is mounted in the case; and

a member cooperates with the case to enclose the propellant charge

the case exterior surface has a plurality of interspersed circumferential grooves and ribs, the ribs having a diameter effective to engage rifling of the barrel.

44. (New) The ammunition of claim 43 wherein there are at least eight said grooves occupying a total of at least about 25% of a length of the case.

45. (New) The ammunition of claim 43 wherein the plurality of grooves have widths of between 0.9mm and 1.8mm peak depths of between 0.08mm and 0.30mm from a maximum case diameter and, along with said ribs extend along at least 70% of the case length.

46. (New) The ammunition of claim 45 wherein said peak depths are between 0.13mm and 0.23mm and said interspersed ungrooved areas have diameters within 0.05mm of the maximum case diameter.

47. (New) The ammunition of claim 45 in combination with an industrial ballistic tool barrel having rifling with a land-to-land diameter which is 0.943-0.950in. and a grove-to-groove diameter which is 0.954-0.960in.

48. (New) The ammunition of claim 45 wherein the case exterior surface has circumferential extractor groove having a depth of at least 1mm and separated by no more than 2mm from an aft extremity of the case.

49. (New) The ammunition of claim 43 wherein the member is a cap extending from a rear rim to a front end and having a rear portion encircling a fore portion of the case.

50. (New) The ammunition of claim 49 wherein:

the cap is formed of a resinous polymer;

the case fore portion includes a flange having an external flange diameter;

the cap rear portion includes an inwardly directed part aft of the flange and having an internal diameter less than the flange diameter so as to cooperate with the flange to resist forward translation of the cap relative to the flange; and

a cap length is between 100% and 300% of a case length.

51. (New) The ammunition of claim 50 wherein:

there is a first radial clearance of at least 1.0 mm between the flange and the cap; and

there is a second radial clearance of between interference fit and 0.5 mm between the cap inwardly directed part and a neck portion of the case aft of the flange.

52. (New) The ammunition of claim 43 wherein the member is a cover having a reduced thickness portion effective so that upon the firing of the propellant charge of a given round a first portion of the cover ahead of the reduced thickness portion will be severed from a second portion aft of the reduced thickness portion and travel behind the spent case of the prior ammunition round.

53. (New) The ammunition of claim 43 wherein the primer is a #209 primer press fit within a head portion of the cast zinc or cast zinc-based alloy case.

REMARKS

In the present Application, claims 1-33 were pending in the IPER. By this Amendment, no claims have been amended, claims 1-21 have been canceled, and claims 34-53 have been added. Accordingly, claims 22-53 are presented and at issue. By this Amendment, claims 22-53 are believed to be in condition for allowance.

All claims 1-33 were found to have industrial applicability. Claims 1-13, 15-29, 32, and 33 were found to have novelty. Claims 15, 16, 18, and 19 were found to have inventive step.

New claims 34, 35, 37, and 38 represent former claims 15, 16, 18, and 19, with the first three thereof being in independent form. New claim 36 represents former claim 17 made dependent on new claim 35.

Claims 14, 30, and 31 based upon Johnsen

Claims 14, 30, and 31 were cited as lacking novelty under PCT Article 33(2) as being anticipated by U.S. Patent No. 3,621,781 of Johnsen. Applicant respectfully traverses the citation.

The examiner asserted that "Fig. 12 discloses a cartridge comprising a metal casing 126 and a cover 124."

Johnsen "relates to cartridges for guns composed of a steel cartridge sleeve having a Teflon or nylon, etc. jacket therearound to prevent excessive friction." Col. 1, lines 11-13.

Johnsen fails to show the method as applied to an industrial ballistic tool as in claims 30 and 31.

Claims 1, 2, 8, 11, 17, and 21-29 based upon Johnsen and Guignet

Claims 1, 2, 8, 11, 17, and 21-29 were cited as lacking an inventive step under PCT Article 33(3) as being obvious over Johnsen in view of Guignet. Applicant respectfully traverses the citation.

The examiner asserted that "Guignet teaches that it is old and well-known in the art to form a case for an ammunition of a zinc-based alloy." The examiner further asserted that the substitution "as taught by Guignet as being an art recognized equivalent material for forming a cartridge case, would have been obvious to one having ordinary skill ..."

Added independent claim 39 references a case formed of a cast zinc or a cast zinc-based alloy.

Guignet discloses drawn metal cartridge shells and identifies that a zinc-copper alloy may be used as "[c]ommercial brass is relatively expensive and cannot readily be drawn into my preferred form." Page 1, lines 94-96. Guignet does not identify how the drawn component would be converted into a case.

Guignet can hardly be properly asserted as teaching that a zinc alloy is the equivalent of any other alloy. Rather, Guignet teaches that zinc alloy is not the equivalent of brass for a highly particularized application. This can hardly be regarded as teaching that such zinc alloy is the equivalent of the steel of Johnsen which is another highly different particularized application. Furthermore, there is no suggestion why one of ordinary skill in the art would apply the teaching of Guignet, which is directed to a particular drawn case "for sporting cartridges" (page 1, lines 5-6) to the unique, different, and very particular ammunition of Johnsen. Thus there is no suggestion for one to attempt to replace the steel sleeve of Johnsen with the drawn material of Guignet, let alone any indication of how this would be accomplished.

Guignet teaches a particular zinc alloy as being uniquely suited for a drawn case. Thus, if anything, it teaches away from casting as specified in claim 39.

Claims 3-6 based upon Johnsen, Guignet, and British Patent No. 3,891

Claims 3-6 were cited as lacking an inventive step under PCT Article 33(3) as being obvious over Johnsen in view of Guignet and British Patent No. 3,891. Applicant respectfully traverses the citation.

Added claim 43 identifies the zinc material and interspersed grooves and ribs.

The inapplicability of Johnsen and its combination with Guignet are identified above.

The British patent was cited as teaching use of a plurality of grooves "to reduce heat transfer." It was further asserted that it would have been obvious "to vary the number and size of the grooves to achieve a desired result."

The British patent, however, is directed to solving barrel heating "[w]hen a rifle is fired a number of times in rapid succession..." Page 1, line 5. The British patent describes a "service rifle" cartridge. Page 1, line 19.

There is no suggestion for one of ordinary skill in art to attempt to apply the teachings of the British patent to Johnsen or a modification thereof. The British patent is directed to a service rifle cartridge, which, in a conventional manner, is chambered, fired, and extracted. As noted above, Johnsen discloses a very particular cartridge including a nylon sleeve. As nylon is

relatively insulating, there is no indication why the Johnsen projectile would require the British modification.

Claim 43 identifies that the ribs have a diameter effective to engage rifling of the barrel. This is not suggested by the British patent which only teaches ribs engaging the chamber. Furthermore, this would be inconsistent with the nylon layer of Johnsen.

Furthermore, no "desired result" is identified by the examiner to be achieved by the claimed dimensions of the dependent claims.

Claim 20 based upon Johnsen and British Patent No. 3,891

Claim 20 was cited as lacking an inventive step under PCT Article 33(3) as being obvious over Johnsen in view of British Patent No. 3,891. Applicant respectfully traverses the citation.

The inapplicability of Johnsen and its combination with the British patent are addressed above.

Claims 32 and 33 based upon Johnsen and Dippold et al.

Claims 32 and 33 were cited as lacking an inventive step under PCT Article 33(3) as being obvious over Johnsen in view of U.S. Patent No. 5,824,944 of Dippold et al. Applicant respectfully traverses the citation.

Dippold was cited as teaching "that it is old and well-known in the art to fire a projectile to remove clinkers from a kiln or remove a plug from a furnace." To employ the Johnsen device to remove clinkers ... as taught by Dippold et al. would have been obvious..." There has been no citation of a motivation for this proposed combination.

Claims 1, 2, 8 and 9 based upon Clas and Guignet

Claims 1, 2, 8 and 9 were cited as lacking an inventive step under PCT Article 33(3) as being obvious over U.S. Patent No. 3,230,884 of Clas in view of U.S. Patent No. 1,974,270 of Guignet. Applicant respectfully traverses the citation.

New independent claim 39 contains elements similar to claim 8.

Clas was asserted as disclosing "the ammunition substantially as claimed" and Guignet was cited as teaching that a zinc-based alloy was "an art recognized equivalent material for forming a cartridge case..."

Clas, however, discloses "blank shells for artillery." Identified gun calibers are 9 cm and 10.5 cm. Col. 3, lines 3 and 31. The shells are identified as including "a shell case, powder

charge and tamping means..." Col. 1, line 36. Furthermore, there is no suggestion why one of ordinary skill in the art would apply the teaching of Guignet, which is directed to a particular drawn case "for sporting cartridges" (page 1, lines 5-6) to another very particular and utterly different artillery shell.

Claim 39 identifies casting. Although, as noted above, there is no suggestion for the proposed combination, the proposed combination also fails to disclose casting.

Claims 3-6 based upon Clas, Guignet, and British Patent No. 3,891

Claims 3-6 were cited as lacking an inventive step under PCT Article 33(3) as being obvious over Clas in view of Guignet and British Patent No. 3,891. Applicant respectfully traverses the citation.

New independent claim 43 incorporates certain elements of former claim 3. The claim also references elements for which the examiner has previously cited Johnsen.

The impropriety of the basic combination of Clas and Guignet is identified above.

Also, as noted above, the British patent describes a "service rifle" cartridge used when a rifle is fired in rapid succession. There is no suggestion why one of ordinary skill in the art would attempt to apply the teaching of a reference regarding rapid fire rifles to artillery blanks or further modify the combination in view of Johnsen.

There is no suggestion why one of ordinary skill in the art would, furthermore, adopt the claimed dimensions of the dependent claims with such an artillery shell. Claim 47 identifies an industrial ballistic tool barrel having particular diameters. There is no suggestion for one of ordinary skill in the art to attempt to insert a 9+ cm artillery blank into such an industrial ballistic tool.

Claims 1, 2, and 8-13, based upon Ballreich et al. and Guignet

Claims 1, 2, and 8-13 were cited as lacking an inventive step under PCT Article 33(3) as being obvious over Ballreich et al. in view of Guignet. Applicant respectfully traverses the citation.

Ballreich et al. was asserted as disclosing "the invention substantially as claimed". Ballreich et al. discloses the use of radiation-crosslinked polyethylene to form training cartridges (e.g., 7.62 mm NATO cartridges). The cartridge profile duplicates the service round profile and, in an embodiment of FIG. 1, the polyethylene component occupies a portion of the cartridge corresponding to the majority of the body of the service round and the projectile of the service

round. Guignet was discussed above. There is no suggestion to apply the particular zinc alloy taught by Guignet as useful in drawn cases to the relatively stubby "metallic bottom piece" of Ballreich et al.

Additionally, as noted above, Guignet's teaching of a particular zinc alloy as uniquely useful in drawn cartridges does not suggest its use in the cast base pieces of claims 39 and 43.

Furthermore, there is no suggestion for the use of a #209 primer or the case mass and diameter of the dependent claims. No "desired result" has been identified which would lead one of ordinary skill in the art to choose these elements.

Similarly, Ballreich et al. teaches the minimization of the size of the metallic piece. Accordingly, there is no suggestion that a cap length be between 100% and 300% of a case length, as identified in claim 50.

Ballreich et al. furthermore fails to disclose the identified first radial clearance of claim 51.

Claims 3-7 based upon Ballreich et al., Guignet, and British Patent No. 3,891

Claims 3-7 were cited as lacking an inventive step under PCT Article 33(3) as being obvious over Ballreich et al. in view of Guignet and British Patent No. 3,891. Applicant respectfully traverses the citation. Added claim 43 incorporates certain elements of former claim 3 as noted above.

The examiner asserted that it would have been obvious "[t]o employ a plurality of grooves on the exterior surface of the ammunition case formed by the combination of Ballreich et al. and Guignet to reduce heat transfer, as taught by the British patent..." and "to vary the number and size of the grooves to achieve a desired result."

The impropriety of the combination of Ballreich et al. and Guignet is addressed above.

Additionally, the British patent shows grooving of the portion of the cartridge which, in Ballreich et al., is formed of polyethylene not the portion formed of metal. Accordingly, there is no suggestion for the grooving of the metallic case as identified in claims 43-48 nor is the any suggestion for the dimensions.

Additionally, as noted above, there is no suggestion for combining the asserted combination with the specified industrial ballistic tool barrel of claim 47.

Please apply any credits or charge any deficiencies to our Deposit Account No. 23-1665.

Respectfully submitted,
Douglas D. Olson, et al.

Date: 3/15/02

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This is the U.S. National Stage of PCT/US00/25866, entitled "INDUSTRIAL AMMUNITION" filed September 21, 2000 and published in English on March 29, 2001 as WO 01/22026 and claims priority to [Priority is claimed of] U.S. Provisional Patent Application 60/155,052, entitled "INDUSTRIAL AMMUNITION AND METHOD AND APPARATUS FOR USE THEREOF" filed September 21, 1999.

INDUSTRIAL AMMUNITION

CROSS-REFERENCE TO RELATED APPLICATION

Priority is claimed of U.S. Provisional Patent Application 60/155,052, entitled "INDUSTRIAL AMMUNITION AND METHOD AND APPARATUS FOR USE THEREOF" filed September 21, 1999.

BACKGROUND OF THE INVENTION

(1) Field of the Invention

This invention relates to industrial ballistic tools, and more particularly to ammunition therefor.

(2) Description of the Related Art

Industrial ballistic tools are used in a variety of applications. One common application is the in situ cleaning of kilns, for which the tools are commonly identified as kiln guns. Additional applications lie in the tapping and cleaning of furnaces, the cleaning of copper smelters, the cleaning and clearing of silos, the cleaning of boilers, and the like.

By way of example, rotary kilns, which are used to calcine cement and lime, are typically 3 to 7 meters in diameter and 30 to 150 meters long. Calcining takes place at elevated temperatures, typically in the range of 1100°C to 1500°C. During the calcining process, because of many processing variables, the product may adhere to the sidewall of the kiln forming a clinker, ring or dam. If this adherent obstruction is not removed, additional product will accumulate, reducing or stopping throughput. Removal of the obstruction is necessary.

It is not economically feasible to stop the kiln to remove the obstruction. Also, considering that the ring may form 5 to 10 meters from the end of the kiln, it is not safe or efficient for an operator to attempt to manually remove the obstruction with a long pole or by like methods. Thus many users of rotary kilns utilize industrial ballistic tools. A tool operator will position the tool in a kiln port and then fire metallic projectiles at the obstruction. Impact of the projectiles with the obstruction removes the obstruction from the sidewall of the kiln. The metallic projectiles are usually formed from lead, a dense material with a relatively low vaporization (boiling) temperature of 1750°C. The lead projectiles knock clinkers from the kiln sidewall and then fall into the kiln and may be vaporized.

Industrial ballistic tools are also utilized by manufacturers of steel, ferrosilicon and other materials. Prior to casting these metals, molten metal is typically contained within an electric furnace sealed by a carbon or clay base plug. Since the molten metal is at a temperature in excess of 2500°C, manual removal of the plug is not feasible. One way that the plug may be removed is with an industrial ballistic tool. A metallic projectile is fired from the industrial ballistic tool to break open the plug, starting the flow of molten metal. To prevent contamination of the metal, the projectile typically is formed of a material such as lead that will vaporize on contact with the molten metal after rupturing the plug.

Due to environmental concerns, lead is being phased out as a projectile material for use with industrial ballistic tools. Zinc and zinc alloys have also been utilized as lead substitutes. Their relatively low density may make them disadvantageous for certain uses. A ballistically stabilized zinc-based projectile is described in U.S. Patent No. 5,824,944 of Jack D. Dippold et al.

Additionally, when repeated firing heats the tool chamber, the plastic tubes of many existing industrial shells may melt and/or leave a residue. The residue may deleteriously affect the firing of subsequent rounds.

In other fields, so-called "bulletless ammunition" has been developed. Cartridges without bullets or other substantial projectiles have been utilized as "blanks" or to propel grenades and the like. However, U.S. Patent No. 3,621,781 discloses bulletless ammunition in which the sidewall of a spent cartridge becomes the projectile propelled by the charge of the subsequent cartridge. In the small arms field, substantial developments in such bulletless ammunition technology were made by Douglas Olson. These include use of cut down brass rifle cases as the case/projectile for use in revolvers and autoloaders. These are discussed in Karwan, C. *Hollowpoint Bulletless Ammo*, *Hi-Tech Firearms*, Petersen Publishing Co., (Oct., 1998), pp. 65-68.

BRIEF SUMMARY OF THE INVENTION

Accordingly, in one aspect, the invention is directed to ammunition for use with a discharging apparatus which has a chamber for receiving the ammunition, a muzzle, and a barrel between the chamber and the muzzle. The ammunition includes a case comprising in major part zinc and extending aft-to-fore from a base to a mouth and having interior and exterior surfaces. A propellant charge is carried within the case. An over-powder member cooperates with the case to enclose the propellant charge. The ammunition lacks a projectile

within the case in a location effective to be expelled from the apparatus and having a mass in excess of a mass of the case.

In various implementations, the case may be a unitary casting of a zinc alloy. The case exterior surface may have at least eight circumferential grooves, the grooves occupying a total of at least about 25% of a length of the case. The plurality of grooves may have widths of between 0.9mm and 1.8mm, peak depths of between 0.08mm and 0.30mm from a maximum case diameter and, along with interspersed ungrooved areas, extend along at least 70% of the case length. The peak depths may be between 0.13mm and 0.23mm and the widths between 1.1mm and 1.5mm. The interspersed ungrooved areas may have diameters within 0.05mm of the maximum case diameter. The ammunition may be combined with an industrial ballistic tool barrel having rifling with a land-to-land diameter which is 0.943-0.950in. (2.395-2.413cm) and a groove-to-groove diameter which is 0.954-0.960in. (2.423-2.438cm). The case exterior surface may have a circumferential extractor groove having a depth of at least 1mm and separated by no more than 2mm from an aft extremity of the case. The ammunition may further include a primer. The primer may comprise a metallic cup mounted in the case base. The primer may be a #209 primer. The case may have a mass of between 70g and 100g, a length of between 50mm and 65mm, and a maximum diameter of between 20mm and 26mm. The over-powder member may be a plug or it may be a cap which extends from a rear rim to a front end and has a rear portion encircling a fore portion of the case. The cap may be formed of a resinous polymer. The case fore portion may include a flange having an external flange diameter. The cap rear portion may include an inwardly directed part aft of the flange and having an external diameter less than the flange diameter so as to cooperate with the flange to resist forward translation of the cap relative to the flange. A cap length may be between 100% and 300% of a case length. There may be a first radial clearance of at least 1.0mm between the flange and the cap. There may be a second radial clearance of between interference fit and 0.5mm between the cap inwardly directed part and a neck portion of the case aft of the flange.

In another aspect, the invention is directed to ammunition for use with a discharging apparatus including a chamber for receiving the ammunition, a muzzle, and a barrel between the chamber and the muzzle. The ammunition extends from a rear end to a front end and includes a metallic case. The case extends aft-to-fore from a base at the ammunition rear end to a mouth and has interior and exterior surfaces. A cover is formed of a polymeric resin and extends from a rear rim to a front end at the ammunition front end. The cover has a mass not in

excess of the mass of the case and has interior and exterior surfaces. The ammunition further includes a propellant charge advantageously confined within at least one of the case and cover.

In various implementation, the case may have a central longitudinal channel extending forward from the primer pocket at the base to a fore portion proximate the mouth. A primer may be mounted within the primer pocket. The propellant charge may be confined within a volume at least partially defined by the central longitudinal channel and the cover interior surface. The cover may have a cover length and the case may have case length less than the cover length. The cover may consist essentially of injection molded high density polyethylene and the case may consist essentially of die cast zinc or zinc alloy. The cover interior surface may have a circumferential recess forward of the case and effective to locally weaken the cover. The weakening is sufficient to permit internal pressure within the cover to sever a portion ahead of the recess from a portion behind which remains attached to the case when the ammunition is fired. The recess may have a longitudinal extent of between 1mm to 5mm and may locally thin the cover to a minimum thickness of between 0.6mm and 1.4mm from an adjacent thickness of between 1.6mm and 2.6mm. The case may have a mass of between 70g and 100g, a length of between 30mm and 40mm, and a maximum diameter of between 20mm and 26mm. The case exterior surface may have a plurality of circumferential grooves, the grooves occupying a total of at least about 25% of a length of the case.

In another aspect, the invention is directed to a method for operating an industrial ballistic tool to discharge a plurality of ammunition rounds. A plurality of ammunition rounds are provided each comprising a zinc case and a charge of propellant. A first such round is inserted into a chamber of the tool. Ignition of the charge of the first ammunition round is caused. A second such ammunition round is inserted into the chamber. Ignition of the charge of the second ammunition round is caused so as to expel the spent case of the first ammunition round out of the muzzle at an effective muzzle kinetic energy.

In various implementation of the invention, the second round insertion and ignition may be repeated, each time utilizing a new ammunition round to expel the case of the previously-discharged round. Prior to insertion of the first round, a chargeless case may be inserted into the chamber so that the insertion of the first round advances the chargeless case toward the muzzle. Prior to insertion of the first round, a preliminary round may be inserted into the chamber. The charge of the preliminary round may not be ignited and insertion of the first round advances the preliminary round toward the muzzle. Alternatively, the charge of the preliminary round may be ignited and insertion of the first round advances the spent case of the

preliminary round toward the muzzle. The muzzle kinetic energy may be at least 10kJ. Insertion of the second round may include engaging an aft end of the spent case of the first round with a fore end of the second round so as to advance the spent case toward the tool muzzle. The ignition of the charge of the second ammunition round may include permitting a first portion of a non-metallic cover portion of the second ammunition round to separate from a remaining second portion and travel behind the spent case of the first ammunition round. This may further comprise permitting the remaining second portion to seal against the chamber to resist combustion gas leakage around the case of the second round.

The present invention may facilitate a number of advantages over prior art slugs. A key potential advantage is cost. Beyond manufacturing cost, costs of collection and disposal of spent hulls is eliminated. Another advantage is that use of a metal case does not entail the melting associated with plastic tubes of conventional industrial ammunition. This may increase reliability.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal cross-sectional view of an ammunition round according to principles of the invention.

FIG. 2 is a semi-schematic longitudinal sectional view of a spent round in the chamber of an industrial ballistic tool.

FIG. 3 is a semi-schematic longitudinal cross-sectional view of a loaded round in the chamber of the tool with the spent round advanced tandemly ahead.

FIG. 4 shows the round and spent case of FIG. 3 shortly after the round is fired.

FIG. 5 shows the round and spent case of FIG. 4 as the spent case advances down the tool barrel.

FIG. 6 is a longitudinal cross-section view of a second ammunition round according to principles of the invention.

FIG. 7 is a semi-schematic cut-away view of the round of FIG. 6 in the chamber of the tool with a spent round advanced tandemly ahead.

FIG. 8 shows the round and spent round of FIG. 7 shortly after the round is fired.

Like reference numbers and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION

The term "ammunition" "round of ammunition", "ammunition cartridge" and the like are commonly associated with a self contained combination of a projectile and propellant, typically with a case for containing the propellant and holding the projectile and a primer for igniting the propellant. When typical ammunition is utilized, the propellant charge of a given round expels the projectile of that round and the spent case is then extracted and replaced with a fresh round. For convenience, terms such as "round" or "cartridge" may be utilized to describe the ammunition of the present invention, even though the rounds do not provide the projectile and propellant for a given firing but, rather, the propellant for one firing and the projectile for the next.

FIG. 1 shows a projectile cartridge 20 including a case 22, a wad 24, a propellant charge 26, and a primer 28. In the prototype embodiment, the case is unitarily formed of machined zinc, although cast zinc is preferred for production, and is symmetric about a central longitudinal axis 500. Other metals, including cast and wrought metals, may be employed. The case extends along the axis 500 from a head 30 at an aft end to a mouth 32 at fore end. The head has fore and aft surfaces 34 and 36. A largely cylindrical primer pocket surface 38 extends forward from the aft surface 36 and terminates at a substantially annular base surface 40. The base surface and primer pocket surface define a primer pocket having a diameter effective to accommodate the primer 28 in a press fit relation, a fore end of the primer abutting the surface 40 and an aft end substantially flush with the aft surface 36. A cylindrical flash hole surface 42 extends forward from the base surface 40 to the fore surface 34 to define a flash hole or venting between the primer pocket and the case interior.

The head includes an extractor/retention groove 50 which separates a rim portion 52 of the head from a web portion 54 of the head and a case body 56. The body has an interior surface 58 which merges with the fore surface 34 of the head to form the case interior surface. An exterior lateral surface 60 of the head and body forms a substantial portion of the case exterior surface.

Internally, the case interior is divided into two volumes 66, 68 by the wad 24: an aft volume or powder (propellant) chamber 66 between the fore surface 34 and an aft surface 70 of the wad; and a forward volume 68 ahead of a fore surface 72 of the wad. With the exception of various relieved areas identified below, the surface 60 is substantially cylindrical, having a diameter D. Along a major portion of the powder chamber, the interior surface 58 has a

diameter D_{PC}. Along a major portion of the forward volume 68, the interior surface has a diameter D_F which is preferably greater than D_{PC} so that the wall thickness of the body is smaller along the forward volume than along the powder chamber.

To secure the wad 24 within the case, an annular internal channel or recess 80 in the body 56 receives an annular projection 82 of the wad. Cylindrical surfaces 84A and 84B on fore and aft sides of the projection 82 engage the surface 58 to provide a seal between the wad and the case. Immediately aft of the surface 84B, the case includes an annular shoulder 86 which divides the portions having respective diameters of D_F and D_{PC}.

Ahead of the extractor groove 50, the exterior lateral surface 60 has an uninterrupted cylindrical portion 87. Ahead of the uninterrupted portion are a series of grooved portions (grooves) and ungrooved portions (ribs/lands) extending over a total length L_l. In the illustrated embodiment, the grooves 88 each have a length L_G while the ribs 89 each have a length L_R which are of similar magnitude. The groove depth is advantageously smaller than these lengths. At the fore end of the case, the exterior and interior surfaces are chamfered at respective angles θ_0 and θ_1 with a flat annular rim 94 therebetween at the case mouth defining frustoconical exterior and interior surface portions 90 and 92.

The preferred primer is a conventional No. 209 shotshell primer or equivalent which includes a forward-facing primer cup having a generally cylindrical sidewall 104 and a web 106 spanning the sidewall and forming an aft end of the primer cup. The primer further includes an aft-facing battery cup having a generally cylindrical sidewall 108 and a web 110 spanning the sidewall at the forward end thereof to define a forward end of the battery cup and primer. The primer cup is press fit within the battery cup adjacent the aft end thereof thus closing the otherwise open aft end. The battery cup is press fit within the head 30 engaging the primer pocket surface 38. Proximate a rim at its aft end, the sidewall 108 is flared outward.

The primer cup contains a primer charge 112 which may be covered by a foil or other layer and may preferably have a lead-free, dinol-based composition. An aft-facing anvil 114 has a base held by the battery cup and a tip extending centrally into the primer cup proximate the primer charge. A circular flash hole 116 is located centrally within the web 110 to provide flash venting extending from the interior of the battery cup to the powder chamber 66. When the primer cup is struck via a firing pin, forward deformation of the web 106 causes the primer charge to impact the anvil tip igniting the primer charge. The ignited primer charge is vented through the flash hole 116 to ignite the propellant 26. In the exemplary embodiment, the flash hole 116 is a single circular aperture having a diameter roughly equal to or in excess of the

0.095 inch (0.24 cm) diameter typical in a No. 209 shotshell primer. In the exemplary embodiment, the base of the anvil has a forward-facing concavity overarching the flash hole. In the exemplary embodiment, the primer has an overall length of about 0.3 inch (0.76 cm) and the battery cup sidewall outer surface has a diameter about 0.24-0.25 inch (0.612-0.635 cm) and preferably of about 0.241-0.245 inch (0.612-0.622 cm) along a major portion surrounding the primer cup. The flaring of the aft end of the battery cup produces a local diameter of about 0.3-0.32 inches (0.76-0.81 cm). Specifically, a forward portion of the battery cup extending along a length of about 0.15-0.16 inch (0.38-0.41 cm) has an predominate external diameter of about 0.241 inch (0.612 cm). The battery cup, having a generally uniform wall thickness of about 0.02 inch (0.051 cm) expands slightly behind the forward section to form a pocket for receiving the primer cup. In this area surrounding the primer cup, the battery cup has a predominate external diameter of about 0.245 inch (0.622 cm) until flaring outward at the aft end.

FIG. 2 schematically illustrates a tool 200 for discharging the inventive ammunition. The tool has a barrel 202 extending along a central longitudinal axis coincident with the projectile axis 500 from a breech end 204 to a muzzle 206. The barrel bore 208 includes rifling 210 extending from a location ahead of the breech to the muzzle. A chamber area 211 extends forward from the breech end. A bolt 212 is shown in a closed position at the breech and carries a firing pin 214 and a retention/extraction member 216. FIG. 2 also shows a spent case 22' positioned in the chamber. The member 216 extends into the extractor groove of the case 22' and its aft surface engages the aft surface of the extractor groove to prevent forward movement of the spent case.

To load a fresh round, the member 216 is withdrawn from the extractor groove, decoupling the spent case from the bolt, and the bolt is withdrawn rearward to an open position (not shown). A fresh round 20 is then fed behind the chamber and driven into the chamber by the bolt 212. A variety of known feed mechanisms may be utilized including various actions and magazines. The insertion of the round 20 into the chamber brings the forward rim 94 of the round into contact with the aft surface 36 of the head of the spent case 22'. The insertion thus drives the spent case from its former chambered or "firing" position of FIG. 2 to a second, "projectile," position of FIG. 3. In the projectile position, the mouth of the spent case is advantageously very close to the aft end of the rifling. In the exemplary embodiment, each land of the rifling includes a bevel 220 at its aft end which provides a transition from the barrel diameter D_G along the chamber and grooves and D_L along the remaining portion of the lands.

In the illustrated embodiment, these bevel surfaces are located adjacent the chamfered surface portion 90 of the spent case in the projectile (FIG. 3).

With the member 216 engaged to the round 20, the pin 214 carried within the bolt 212 is driven forward and strikes the aft surface of the web 106 of the primer cup. The engagement between the member 216 and the round 20 prevents the firing pin impact from driving the round 20 forward without igniting the primer. The impact deforms the web forward and drives the primer charge against the anvil, igniting the primer charge. Hot combustion gases and flames from the burning primer are vented through the flash holes of the battery cup and case and into the propellant chamber 66 whereupon they ignite the propellant. Combustion gases generated by the burning propellant raise the pressure within the propellant chamber sufficiently to drive the wad 24 out of engagement with the channel 80, driving the wad through the forward volume 68 toward the spent case (FIG. 4).

The wad 24 is driven into engagement with the aft surface 36 of the head of the spent case. Pressure from the combustion gases compress the wad against the spent case. Under such pressure, the wad deforms radially outward so that its circumferential perimeter bears against and obturates the barrel to prevent flow of combustion gas ahead of the wad and thus around and ahead of the spent case/projectile. Expanding combustion gases then propel the wad 24 and spent case/projectile down the barrel (FIG. 5) and expel them from the muzzle. An additional role of the wad may be to shield the primer cup of the spent case/projectile from the combustion gases. Otherwise, the primer cup might not be able to withstand the pressure and could rupture, allowing the combustion gases to flow into the spent case/projectile and, thereby, reduce the net force applied to the spent case/projectile.

The process may then be repeated. Optionally, if no spent case is initially present, an unspent round may be inserted into the chamber and then driven forward to the projectile position by a second unspent round and launched. Additionally, if it is desired to remove a spent or unspent round from the chamber (such as for tool servicing or to remove a misfired round), the member 216 is left in place as the bolt is withdrawn and the case or the round ejected as with conventional ballistic tools and firearms.

An alternative method of operation involves advancing the spent case from the chambered position to the projectile position prior to insertion of the next round. This can be accomplished, for example, by a piston mounted within the bolt. This mode of operation reduces the insertion force required to insert the unspent round.

A preferred case material is zinc alloy AG40A, having nominal composition by weight: Cu 0.25% max; Al 3.5-4.3%; Mg 0.020-0.05%; Pb 0.005% max; Cd 0.004% max; Sn 0.003% max; and balance Zn. Other alloys may, however, be utilized. Conventional die casting techniques may be utilized. Other manufacturing techniques, *e.g.*, semisolid casting (rheocasting or thixocasting), nucleated casting, and slush casting may be utilized.

Conventional eight-gauge industrial ballistic tools have a bore diameter (groove-to-groove if rifled) of about 0.830 + 0.05 in. (2.11 + 0.13 cm). An 8-gauge version of the present ammunition might risk accidental attempts to use conventional ammunition in a tool configured for the inventive round or vice versa. Also, such a size would present difficulties in providing the desired 3 oz. (85 g) case weight. Accordingly, the case is dimensioned for use with a barrel having significantly larger land and groove diameters. With such a barrel, the presently preferred land-to-land diameter is 0.946 in. (2.403 cm) while the preferred groove-to-groove diameter is 0.958 in. (2.433 cm). These larger dimensions allow the case to meet the weight goal while having appropriate wall thickness, powder chamber volume, and volume ahead of the wad. The case diameter also defeats attempts to use the preferred inventive ammunition in conventional tools and vice versa. For such barrel dimensions, a particularly preferred case diameter D is 0.956-0.958 in. (2.428-2.433 cm). This provides the maximum case diameter along the uninterrupted portion 87 and along the ribs 89. This diameter is effective to allow the associated portions to be engraved by the rifling to induce spin and to obturate with the remaining bore surface. In the absence of the grooves 88, the drag forces between the barrel and case/projectile would be excessive, causing loss of muzzle velocity, and undue barrel wear and heating. The rounds, however, may also be utilized with smoothbore tools with or without rifled extensions.

A number of factors go into the selection of the geometry and dimensions of the grooves and ribs. The greater the total length of the relieved areas (and thus the lesser the areas at or substantially at the diameter D), the lower the frictional drag from engagement with the barrel. Because of the effect of chamber pressure, the length of any given groove should not be so great that the chamber pressure can cause the case body to buckle outward along such area. Similarly, the length of each of the interspersed ribs should not be so small that the chamber pressure can cause a crushing of such ribs which would, thereby, also drive the grooved areas radially outward. The groove depths should be sufficient for the friction reduction but not so large as to either weaken the body and allow the aforementioned bowing out or unduly decrease the case mass which is important for maintaining the desired kinetic energy. These

factors lead to the arrangement of ribs and grooves over a substantial length of the case. The exemplary ribs and grooves each have lengths of 0.050 +/-0.005 in. (0.127 +/- 0.013 cm) and commence at a distance of 0.625 +/-0.005 in. (0.159 +/- 0.013 cm) from the aft extremity of the aft surface 36 and extend all the way to the exterior chamfered surface portion 90.

For the chamfered surface portions 90 and 92, particularly preferred angles θ_O and θ_I are 15° +/- 1° and 5° +/- 0.5°. The chamfered surface portion 90 preferably extends along a length of at least about 0.1 in. (0.25 cm) to provide a degree of improved aerodynamics as well as to facilitate chambering of the rounds. Such length may be affected by whether the surface portion 90 meets a groove or a rib, a preferred length being between about 0.125 in. (0.318 cm) and about 0.16 in. (0.406 cm). The angle θ_I is effective to ease insertion of the wad 24 through the case mouth but chosen to not unduly thin the case at the mouth or unduly constrain the length of the exterior chamfered surface portion 90.

Additionally, in the exemplary embodiment the case rim 52 may be slightly rebated (e.g., to an exemplary rim diameter similar to the diameter of the grooves 88). The extractor/retention groove 50 is, clearly, further relieved, for example to a diameter of 0.845-0.850 in. (2.145-2.159 cm), its aft surface being substantially radial and its fore surface being frustoconical, e.g., at a cone angle of about 45°, leaving a cylindrical portion in between of about 0.085-0.090 in. (0.216-0.219 cm) in length. An exemplary rim thickness or length is 0.072-0.078 in. (0.183-0.198 cm).

The wad 24 serves to encapsulate the propellant within the powder chamber. The wad should have sufficient robustness to do this throughout an anticipated range of handling conditions. It is also desirable that the wad, and its engagement to the case, be sufficiently robust to allow a moderate increase in chamber pressure when the round is fired and before the wad is driven forward. The wad should be sufficiently thin and, thereby, leave the forward volume 68 with a sufficient length to yield lower peak chamber pressures than would be present if the wad extended all the way between the powdered chamber and the mouth. The wad should also be lightweight, to avoid detracting from the kinetic energy imparted to the spent case/projectile. Accordingly, the exemplary wad is molded of a plastic material polyethylene, preferably low density polyethylene (LDPE) is believed to provide an advantageous combination of strength and formability for the wad. To further reduce weight relative to its sealing capability, the fore and aft surfaces 72 and 70 are formed with a central depression, being flat nearly all the way to the outer periphery of the wad and having a fillet-like transition to the associated rim 73A, 73B of near vanishing thickness.

As noted above, the dimensions of the forward volume 68 are particularly relevant to controlling peak chamber pressure. Both volume and length may be relevant parameters. The volume of the propellant chamber will largely be constrained by the required amount of propellant. For an exemplary case having a mass of 3.0 oz. (85 g), an exemplary propellant charge is 93 grains (6.0 g) of OBP615 BALL POWDER propellant available from Olin Corporation, East Alton, IL, under license from Primex Technologies, Inc., St. Petersburg, FL. For such a charge, a propellant chamber volume in the vicinity of or somewhat greater than 0.3803 in.^{3} (6.24 cm^3) is preferred. A number of factors will ultimately influence the desired case length, wall thickness, and thus the size of the forward volume 68. The length has an influence on aerodynamics and the wall thickness (by effecting the amount of the remainder of the weight which is found in the case head) influences balance. Both aerodynamics and balance may affect ballistic performance. The case length and wall thickness also influence impact performance. A relatively long case wall may be more likely to deform upon impact. This deformation may reduce the impact shock of the projectile, thus reducing its usefulness for many applications. The deformation may also help deflect the projectile, potentially also reducing effectiveness. With the foregoing in mind, it is believed that a thin, short sidewall is advantageous for many industrial applications. This maximizes the mass represented by the head. If the sidewall is sufficiently thin to be easily deformed by the impact, such deformation will absorb a relatively small amount of energy. The remaining energy of the head impacting the target will still be effective for the intended purpose.

The dimensions of the forward volume 68 are, however, also relevant to controlling peak chamber pressures. For a given projectile mass, various different muzzle velocities may be desired for various different applications. The different applications may entail use of different amounts of propellant and/or propellant types (burn rates). It is believed that for most, if not substantially all, applications, a relatively small forward volume will be sufficient for chamber pressure control and thus desirable due to the impact-enhancing advantages of the short projectile length associated with the small forward volume. It is theorized that a forward volume having a length as little as 0.05 inches should be sufficient to provide chamber pressure control adequate for a ballistic tool used in applications for which present eight-gauge are effective. Thus an appropriate goal for the length of such forward volume would be in the vicinity of about 0.05 inch to about 0.1 inch. Depending on wall thickness, with such a relatively small forward volume the overall case length could be in the range of about 1.5 inches to about 1.75 inches. For such a case, the head length L_H and the length L_W of the flash

hole surface 42 and center of the web portion 54 will both be increased by about 0.2 inch to 0.4 inch above the exemplary prototype dimensions of 0.50 inch and 0.195 inch respectively. Another envisioned modification is an alteration of the diameter of the flash hole surface 42 from the prototype dimension of 0.10 inch. A decrease in this diameter (*e.g.*, toward 0.80 inch) has an advantage of concentrating mass at the head. If the diameter is too small, primer recoil might occur. Given the length L_W, a significant amount of propellant may be contained within the flash hole surface 42 (which thus serves as a flash tube). A larger diameter and its associated larger amount of propellant may lead to more rapid ignition of the main body of propellant within the powder chamber. Thus a smaller diameter may be advantageous if a less rapid ignition is desired, for example, to help control peak chamber pressures.

FIG. 6 shows an alternate cartridge 320 including a case 322, a cover 324, a propellant charge 326 and a primer 328. Subject to the discussion below, various properties and dimensions of the cartridge 320 may be the same as or similar to those of the cartridge 20 of FIG. 1. The case is preferably a one-piece casting of zinc or a zinc-based alloy while the cover is preferably a one-molding of low density polyethylene. The case head 330 may be similarly shaped to the head 30 of the case of FIG. 1, while features proximate the mouth 332 are formed to cooperate with the cover 324. The head has fore and aft surfaces 334 and 336. A primer pocket 338 joined at a base surface 340 to a flash hole surface 342 may be similarly formed to that of the case of FIG. 1. In order to ease manufacturing, the flash hole may preferably have at least a slight (e.g., 1°) fore-to-aft taper. Extractor/retention groove 350, rim 352, and web 354 may be similarly formed to corresponding elements of the case of FIG. 1. The wall thickness of the body 356 is generally greater than that of the case of FIG. 1, with a body interior surface being of relatively smaller diameter while body exterior lateral surface 360 may be of similar diameter. A main portion of the body 356 terminates at an annular forward-facing shoulder 362. A neck 364 extends forward from the shoulder to a flange 366 having a diameter intermediate those of the neck and body main portion. At its forward extremity, the flange is chamferred or bevelled both internally and externally. The body interior surface 358 extends continuously through the flange, neck and main body portion having a fore-to-aft taper. The body interior surface 358 cooperates with the flash hole surface 342 and primer pocket surface 338 to form a central longitudinal channel extending through the case.

The cover 324 includes an inwardly-directed flange 368 at an aft rim 369. An inwardly-facing surface 370 defining a central aperture in the cover flange 368 has a diameter smaller than a diameter of an external cylindrical surface of the case flange 366. This permits

the cover flange 368 to be captured between the case flange 366 and the shoulder 362. In the exemplary embodiment, there is a radial gap or clearance between the case flange 366 and the cover interior surface 372 so that the aft surface or underside of the case flange 366 covers and contacts only an inboard portion of a forward facing surface of the cover flange 368. In its installed condition, the cover cooperates with the body interior surface to define a powder chamber containing the charge 326. In the exemplary embodiment, the powder chamber has substantially more volume than is necessary to contain the charge. The charge may be unrestrained within this additional space or an additional member such as a wad may be located within the cover to further confine the charge.

At an intermediate position along the length of the cover, the cover is locally weakened such as by provision of an annular channel 374 in the interior surface 372. The channel 374 divides fore and aft portions 375A and 375B of the cover 324. An exemplary channel 374 is formed as a full radius channel having a depth half its longitudinal extent. The cover exterior surface 376 is generally cylindrical from the rim 369 forward to a rounded transition (e.g., I/O radius of 0.25 in.(0.64 cm)) to a flattened front end 378.

The case exterior surface 360 is advantageously provided with an alternating series of grooves 388 and ribs 389.

Exemplary manufacturing dimensions of one implementation are as follows:

Dimension	Value (in.(cm) unless noted)
Rim diameter	0.937-0.003(2.380-0.008)
Rim length	0.075-0.003(0.191-0.008)
Extractor groove base diameter	0.850-0.005(2.16-0.013)
Extractor groove base length	0.085+0.005(0.216+0.013)
Neck length	0.100+0.005(0.254+0.013)
Neck diameter	0.500+/-0.003(1.27+/-0.01)
Case flange length	0.250+/-0.005(0.635+/-0.013)
Case flange diameter	0.588+/-0.003(1.494+/-0.008)
Case flange I/O chamfer	0.02(0.05) x 45°
Head fore surface diameter	0.240 +/- 0.005(0.610+/-0.013)
Case interior taper	2° +/- 10'
Rib and groove pitch	0.100(0.254)
Rib length	0.032+/-0.005(0.081+/-0.013)
Maximum case (rib) diameter	0.955-0.003(2.426-0.008)
Groove diameter	0.944-0.004(2.395-0.010)
Overall length	2.938(7.463)nominal
Case length	1.363+/-0.003(3.462+/-0.008)
Cover length	1.825+/-0.050(4.636+/-0.127)
Cover outer diameter	0.943+/-0.005(2.395+/-0.013)
Cover principal inner diameter	0.780+/-0.010(1.981+/-0.254)
Cover flange thickness	0.100+/-0.005(0.254+/-0.013)
Cover flange inner diameter	0.500+/-0.003(1.270+/-0.008)
Cover groove depth	0.040(0.102)
Flash hole length	0.50(1.27)
Flash hole diameter	0.10(0.25)
Case mass	3.00+/-0.01oz. (85.0+/-0.3g)
Cover mass	6.5+/-0.1g
Propellant charge	90 grains (5.8g)

Relative to the cartridge 20, the foregoing dimensions provide the cartridge 320 with both a smaller maximum diameter and a smaller total length of material at that maximum diameter. This reduces barrel wear and the required insertion force to chamber a round and drive a spent round forward into the projectile position.

Various parameters of use of the cartridge of FIG. 6 may be similar to that of the cartridge of FIG. 1 and are not repeated in detail. However, FIG. 7 shows an unfired cartridge 320 chambered behind a spent cartridge 320' analogous to the illustration of FIG. 3. The spent cartridge comprises the case, spent primer, and aft portion of the cover of the previously-fired round. When the cartridge 320 is fired, pressure increases within its cover. The pressure increase is effective to rupture the cover at the channel 374 separating the fore cover portion from the aft cover portion (FIG. 8) and permitting expanding gas to drive the fore portion along with the spent cartridge ahead down the barrel. The fore cover portion can provide a significant degree of obturation, significantly preventing combustion gasses from passing around the spent case/projectile. This, in large part, facilitates a relatively low maximum case diameter and a relatively low portion of material at that maximum diameter by reducing the need for the case/projectile to obturate itself.

Additionally, the aft cover portion helps prevent combustion gasses from flowing back around the case being fired. The presence of the radial gap between the case flange 366 and cover interior surface 372 permits combustion gas pressure to act on the adjacent portion of the fore surface of the cover flange 368 pressing the aft surface thereof into firmer engagement with the case shoulder surface 362 to resist infiltration of combustion gasses between the cover and case and thereby around the case.

Because of the possibility of additional wadding, encapsulating material, or the like, and to avoid any confusion regarding the scope of the claims, as such items are argued as being "projectiles" various claims may identify a lack of a substantial or effective projectile by defining a maximum mass of any item which could be asserted as a projectile. Where dimensions are given in both English and metric units, the English units are the original value and the metric units are a conversion.

One or more embodiments of the present invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. For example, although various preferred dimensions have been identified, there remains flexibility in choosing the particular dimensions of a particular

cartridge. If compatibility with the preferred cartridge (or with any particular cartridge) is desired, then flexibility in certain of the dimensions may be highly limited. Accordingly, other embodiments are within the scope of the following claims.

CLAIMS

WHAT IS CLAIMED IS:

1. Ammunition (20; 320) for use with a discharging apparatus that includes a chamber for receiving the ammunition, a muzzle and a barrel between the chamber and the muzzle, the ammunition comprising:

a case (22; 322) formed of zinc or a zinc-based alloy that extends aft-to-fore from a base to a mouth and has interior and exterior surfaces;

a propellant charge (26; 326) contained within the case; and

a member (24; 324) cooperating with the case to enclose the propellant charge, said ammunition lacking a projectile having a mass in excess of a mass of the case.

2. The ammunition of claim 1 wherein the case (22; 322) is a unitary casting of a zinc alloy.

3. The ammunition of claim 1 wherein the case exterior surface (60; 360) has at least eight circumferential grooves (88; 388) said grooves occupying a total of at least about 25% of a length of the case.

4. The ammunition of claim 3 wherein the plurality of grooves (88; 388) have widths of between 0.9mm and 1.8mm peak depths of between 0.08mm and 0.30mm from a maximum case diameter and, along with interspersed ungrooved areas extend along at least 70% of the case length.

5. The ammunition of claim 4 wherein said peak depths are between 0.13mm and 0.23mm and said interspersed ungrooved areas have diameters within 0.05mm of the maximum case diameter.

6. The ammunition of claim 4 in combination with an industrial ballistic tool barrel (202) having rifling (210) with a land-to-land diameter which is 0.943-0.950in. (2.395-2.413cm) and a grove-to-groove diameter which is 0.954-0.960in. (2.423-2.438cm).

7. The ammunition of claim 4 wherein the case exterior surface has circumferential extractor groove (50; 350) having a depth of at least 1mm and separated by no more than 2mm from an aft extremity of the case.

8. The ammunition of claim 1 further comprising a primer (28; 328).

9. The ammunition of claim 8 wherein the primer comprises a metallic cup mounted in the case base.

10. The ammunition of claim 9 wherein:

the primer is a #209 primer; and

the case has a mass of between 70g and 100g and a maximum diameter of between 20mm and 26mm.

11. The ammunition of claim 1 wherein the member (324) is a cap extending from a rear rim (369) to a front end (378) and having a rear portion encircling a fore portion of the case.

12. The ammunition of claim 11 wherein:

the cap (324) is formed of a resinous polymer;

the case fore portion includes a flange (366) having an external flange diameter;

the cap rear portion includes an inwardly directed part (368) aft of the flange (366) and having an internal diameter less than the flange diameter so as to cooperate with the flange to resist forward translation of the cap relative to the flange; and

a cap length is between 100% and 300% of a case length.

13. The ammunition of claim 12 wherein:

there is a first radial clearance of at least 1.0 mm between the flange (366) and the cap (324); and

there is a second radial clearance of between interference fit and 0.5 mm between the cap inwardly directed part (368) and a neck portion (364) of the case aft of the flange (366).

14. Ammunition (320) in combination with a discharging apparatus for firing such ammunition wherein:

the discharging apparatus comprises:

a chamber for receiving the ammunition;

a muzzle; and

a barrel between the chamber and the muzzle; and

the ammunition extends from a rear end to a front end and comprises:

a metallic case (322) that extends aft-to-fore from a base (336) at the ammunition rear end to a mouth (332) and has interior and exterior surfaces, the metallic case having a length and diameter effective to be initially accommodated within the chamber and then, after firing, to be driven forward into the barrel and discharged therefrom by such firing of a subsequent similar ammunition;

a cover (324) formed of polymeric resin and extending from a rear rim to a front end at the ammunition front end and having a mass not in excess of a mass of the case and having interior (372) and exterior surfaces (376); and

a propellant charge (326) confined within a volume at least partially defined by a combination of said case and said cover.

15. The combination of claim 14 wherein:

the case has a central longitudinal channel extending forward from a primer pocket portion at the base to a fore portion proximate the mouth;

a primer is mounted within the primer pocket; and

said volume is at least partially defined by the central longitudinal channel and the cover interior surface.

16. The combination of claim 14 wherein:

the cover has a cover length; and

the case has a case length, less than the cover length.

17. The combination of claim 14 wherein:

the cover consists essentially of injection molded high density polyethylene; and

the case consists essentially of die cast zinc or zinc alloy.

18. The combination of claim 14 wherein the cover interior surface (372) has a circumferential recess (374) forward of the case and effective to locally weaken the cover

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sufficiently to permit internal pressure within the cover to sever a portion (375A) ahead of the recess from a portion (375B) behind the recess while the portion behind remains attached to the case when the ammunition is fired.

19. The combination of claim 18 wherein the circumferential recess:

has a longitudinal extent of between 1mm and 5mm; and

locally thins the cover to a minimum thickness of between 0.6mm and 1.4mm from an adjacent thickness of between 1.6mm and 2.6mm.

20. The combination of claim 14 wherein:

the case has a mass of between 70g and 100g, a length of between 30mm and 40mm, and a maximum diameter of between 20mm and 26mm;

the case exterior surface has a plurality of circumferential grooves (388), said grooves occupying a total of at least about 25% of a length of the case.

21. The combination of claim 14 wherein:

the case consists essentially of zinc or a zinc-based alloy

22. A method for operating an industrial ballistic tool to discharge a plurality of ammunition rounds, each having a case and a charge of propellant comprising:

(a) providing a plurality of such ammunition rounds each comprising a zinc case;

(b) inserting a first such ammunition round into a chamber of the tool;

(c) causing ignition of the charge of the first ammunition round;

(d) inserting a second such ammunition round into the chamber; and

(e) causing ignition of the charge of the second ammunition round so as to expel the spent case of the first ammunition round out of a muzzle of the tool at a muzzle kinetic energy.

23. The method of claim 22 further comprising:

repeating steps (d) through (e), each time utilizing a new ammunition round to expel the case of the previously-discharged round.

24. The method of claim 22 further comprising:

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prior to insertion of the first round, inserting a chargeless case into the chamber so that the insertion of the first round advances the chargeless case toward the muzzle.

25. The method of claim 22 further comprising:

prior to insertion of the first round, inserting a preliminary round into the chamber, but not causing ignition of the charge of the preliminary round, so that the insertion of the first round advances the preliminary round toward the muzzle.

26. The method of claim 22 further comprising:

prior to insertion of the first round, inserting a preliminary round into the chamber and causing ignition of the charge of the preliminary round, so that the insertion of the first round advances the spent case of the preliminary round toward the muzzle.

27. The method of claim 22 wherein:

the muzzle kinetic energy is at least 10kJ.

28. The method of claim 22 wherein:

step (e) comprises permitting a first portion of a non-metallic cover portion of the second ammunition round to separate from a remaining second portion and travel behind the spent case of the first ammunition round to provide obturation; and

step (d) comprises engaging an aft end of the spent case of the first ammunition round with a fore end of the second such ammunition round so as to advance the spent case toward the muzzle.

29. The method of claim 22 wherein step (e) comprises:

permitting a first portion of a non-metallic cover portion of the second ammunition round to separate from a remaining second portion and travel behind the spent case of the first ammunition round; and

permitting the remaining second portion to seal against the chamber to resist combustion gas leakage around the case of the second round.

30. A method for operating an industrial ballistic tool to discharge a plurality of ammunition rounds, each having a case and a charge of propellant comprising:

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(a) providing a plurality of ammunition rounds;

(b) inserting a first such ammunition round into a chamber of the tool;

(c) causing ignition of the charge of the first ammunition round;

(d) inserting a second such ammunition round into the chamber, so as to advance the spent case of the first ammunition round toward a muzzle of the tool; and

(e) causing ignition of the charge of the second ammunition round so as to expel the spent case of the first ammunition round out of the muzzle.

31. The method of claim 30 further comprising:

repeating steps (d) through (e), each time utilizing a new ammunition round to expel the case of the previously-discharged round.

32. The method of claim 30 wherein said expulsion causes said spent case to at least one of:

impact adherent to remove such adherent form a surface; or

break open a furnace plug.

33. The method of claim 30 wherein said expulsion causes said spent case to at least one of:

knock a clinker from a kiln sidewall; or

break open a furnace plug.

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

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Published:
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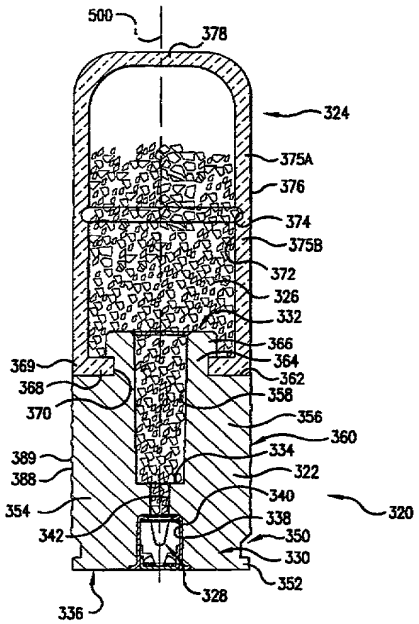
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: INDUSTRIAL AMMUNITION



(57) Abstract: A projectileless ammunition system (20; 320) includes a metallic case (22; 322). A propellant charge (26; 326) is carried by the case and covered by an over-powder member (24; 324) in the absence of a separate projectile. The ammunition is advantageously used with an industrial ballistic tool operating so that each spent case serves as the effective projectile to be propelled by firing of the next round of ammunition.

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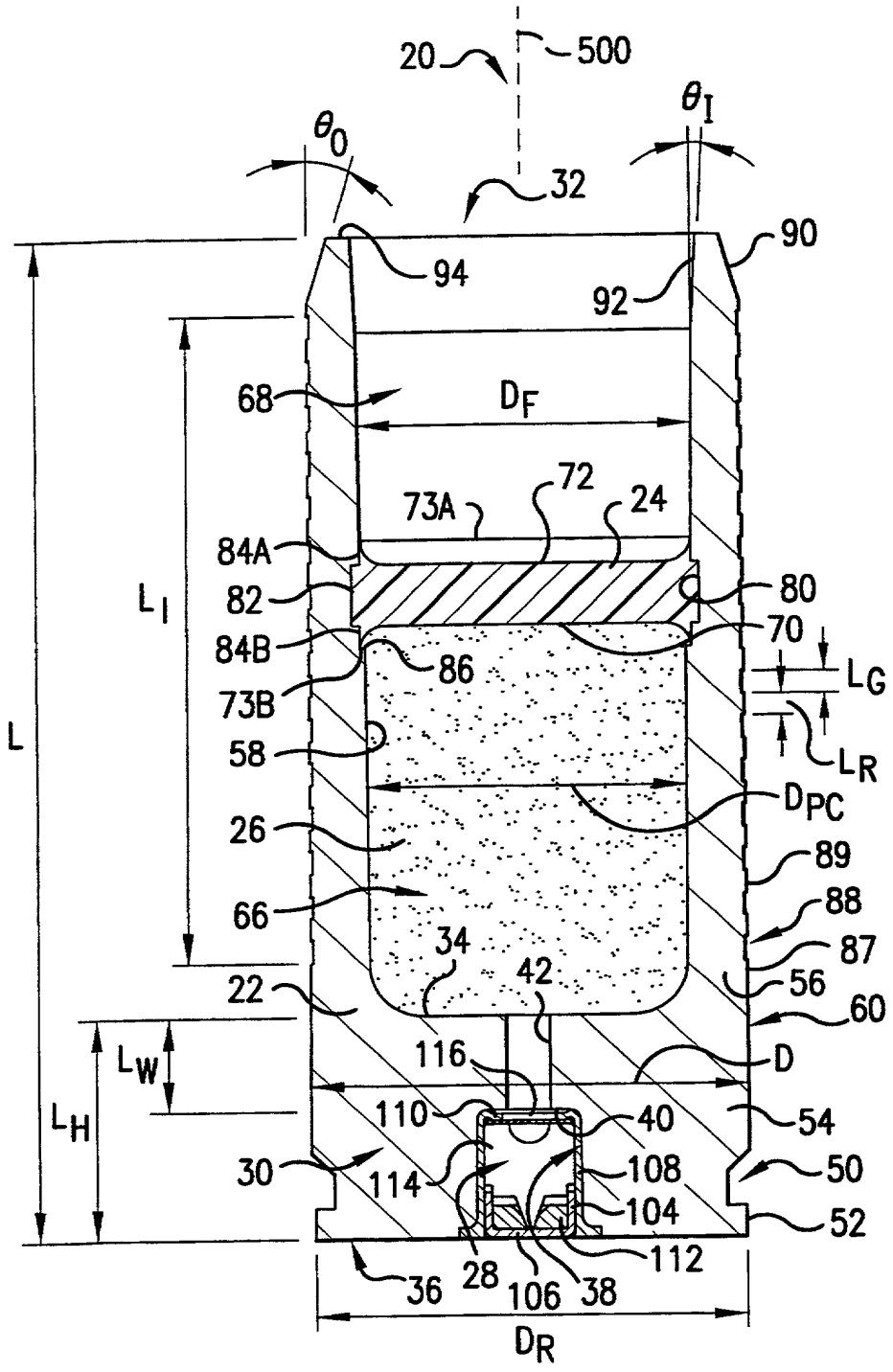
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84B
86
L_G
73B
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L_R
L
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26
89
66
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34
87
42
22
56
60
116
D
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106
38
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FIG.1

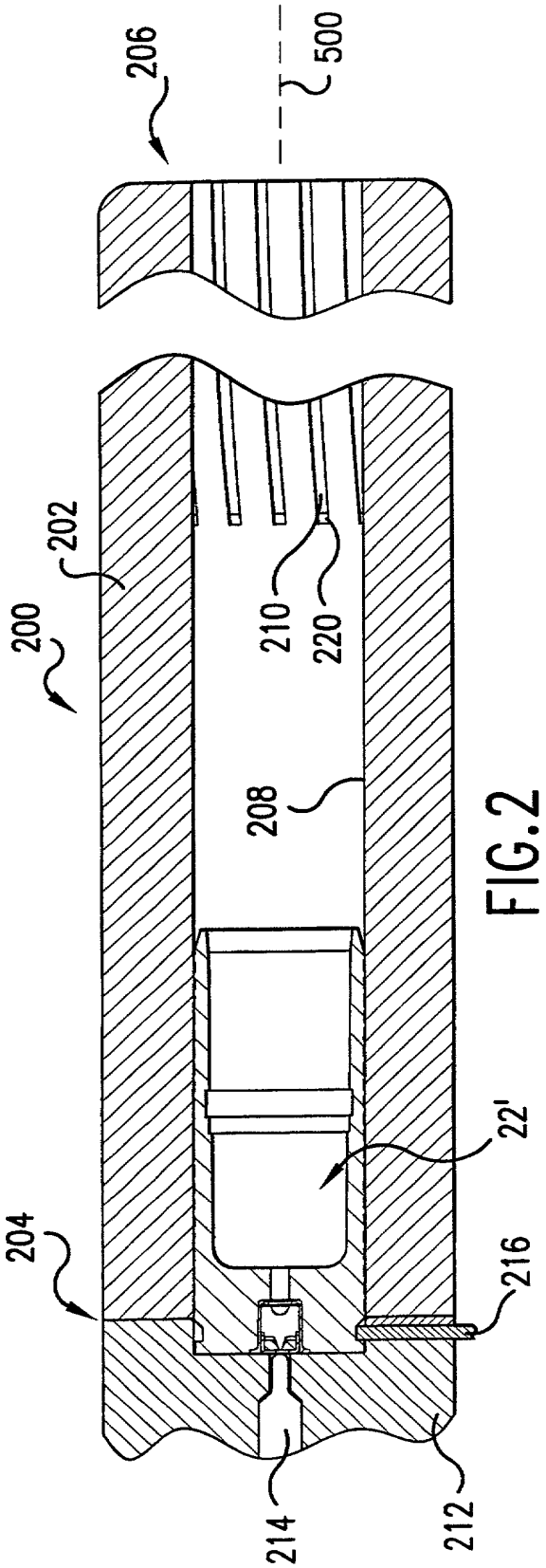

FIG.2

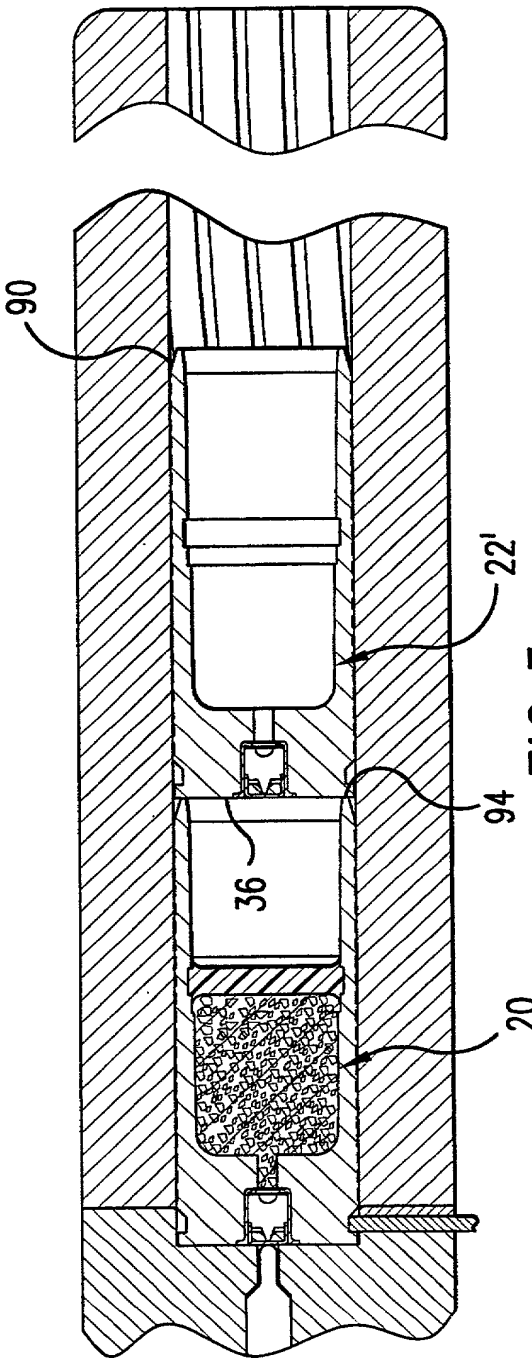

FIG.3

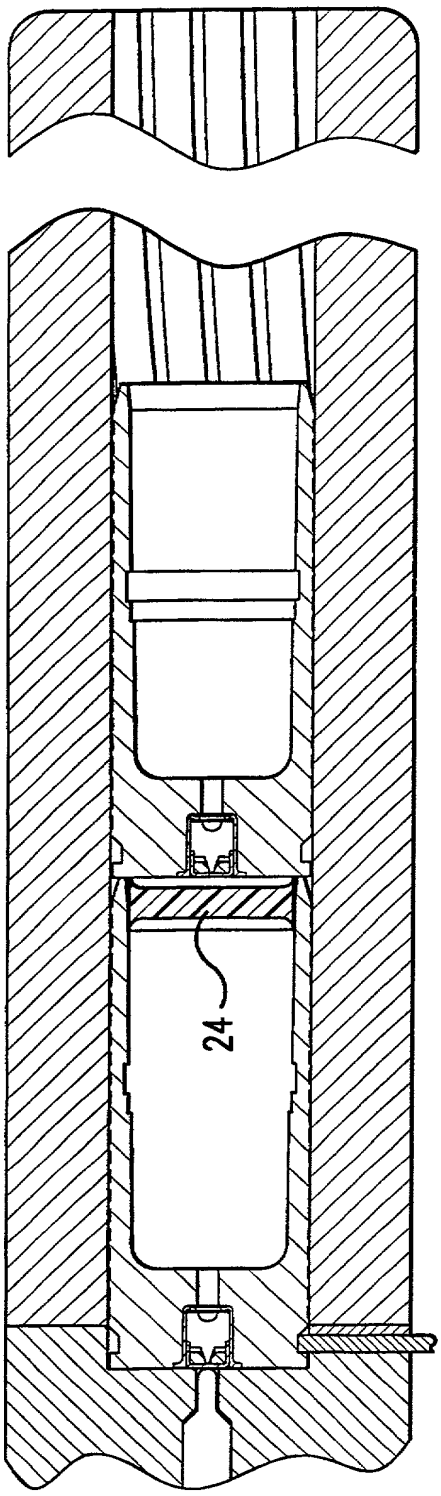

FIG.4

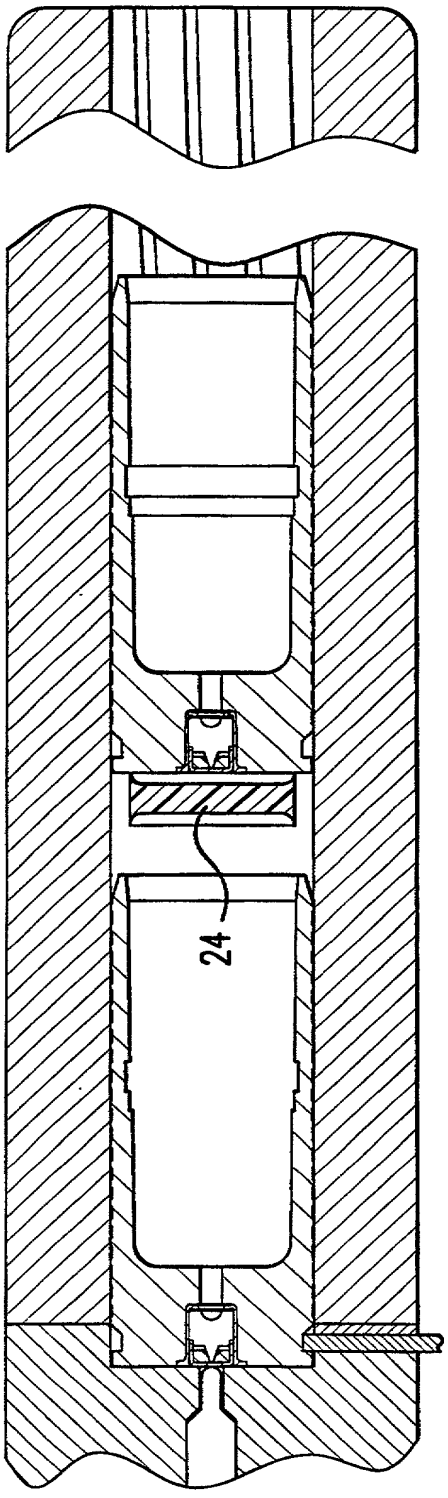

FIG.5

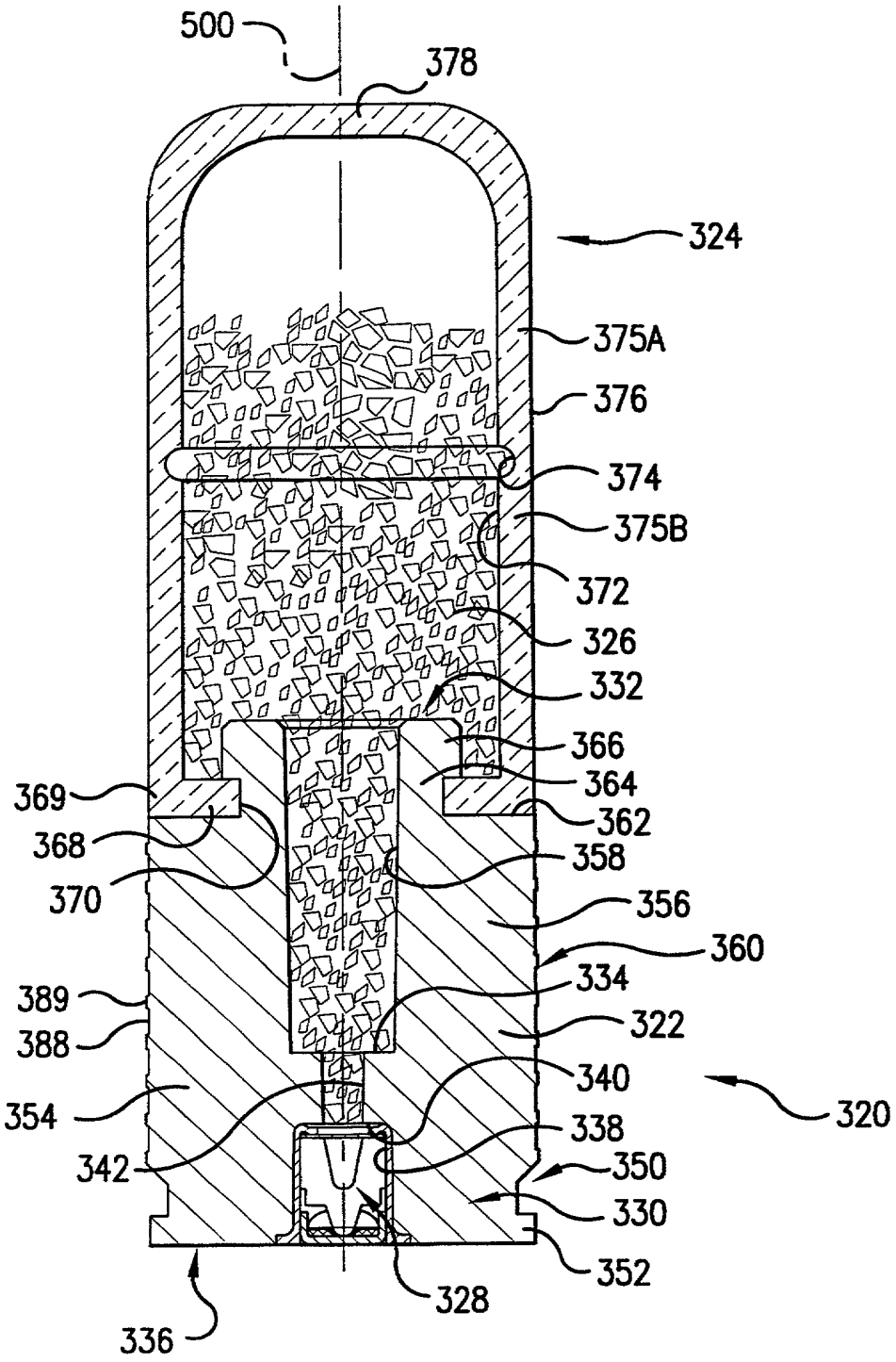
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FIG.6

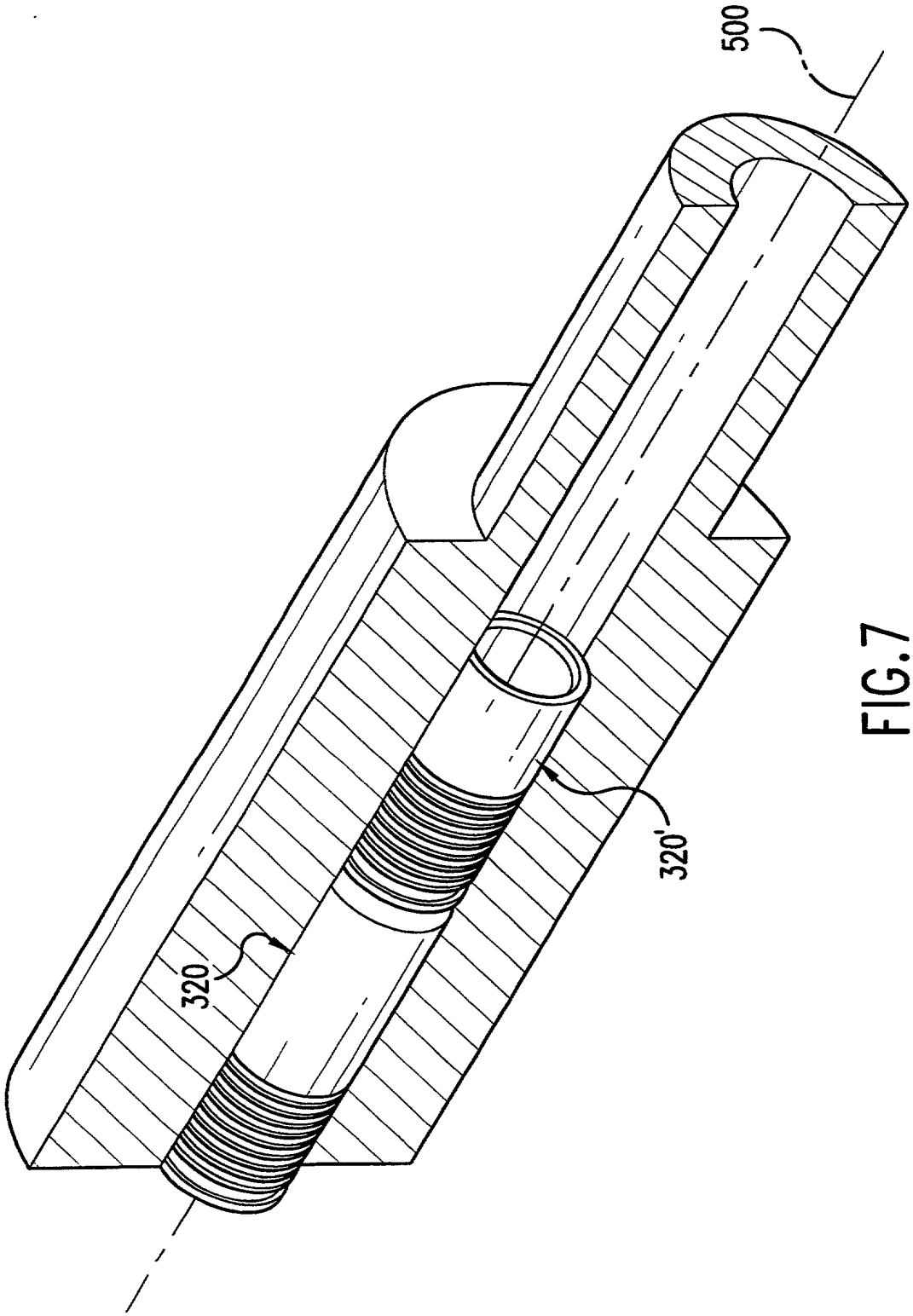

FIG.7

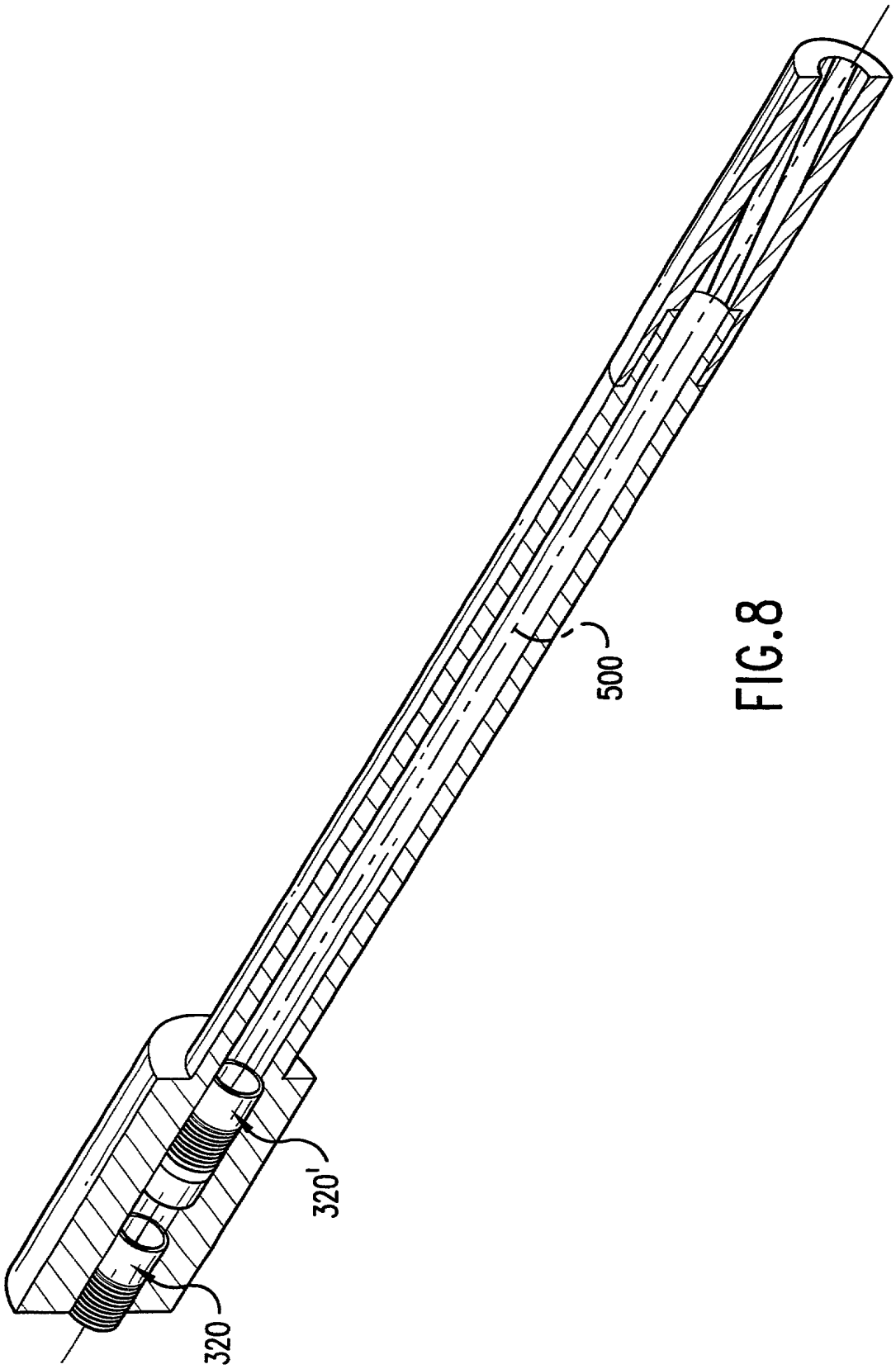

FIG.8

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Douglas D. Olson, et al.	Docket No.:	102031-201
Serial No.:	U.S. National Phase of PCT/US00/25866	Art Unit:	N/A
Filed:	September 21, 2000	Examiner:	N/A
Assignee:	Olin Corporation		
Title:	Industrial Ammunition		

APPOINTMENT OF ATTORNEY

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Olin Corporation ("Assignee"), a Virginia company, states that it is the assignee of the entire right, title, and interest to the above-identified application by virtue of a chain of title from the inventors Douglas D. Olson, Jack D. Dippold and Randant D. Huelsmann to Assignee by assignment executed 2/14/02, 2/12/02 and 2/12/02. A copy of this assignment is attached.

The undersigned is empowered to sign this statement on behalf of Assignee.

Assignee hereby appoints the practitioners at Customer Number 27267:

27267
PATENT TRADEMARK OFFICE

to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Please the correspondence for this application to the above-identified customer number. Please direct any telephone inquiries to William B. Slate at 203-498-4373.

Respectfully submitted,
OLIN CORPORATION

Theodore A. Zimmermann
Assistant Secretary

Date: 3/8/02

Enclosure: Assignment

6%#L01!.DOC\12868\13\319341.01

pet 3/7/02

DECLARATION FOR JOINT INVENTORS

1. As below named joint inventors, we hereby declare that our addresses and citizenship are as stated below next to our names. We believe we are the original and first inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled:

"INDUSTRIAL AMMUNITION"

the specification of which:

[ ] is attached or

[X] was filed on September 21, 2000 as Serial No. PCT/US00/25866 and amended on August 30, 2001.

2. We hereby state that we have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment specifically referred to above.

3. We acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. 1.56.

4. [ ] We hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate or §365(a) of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by us on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

Country	Application Serial No.	Date of Filing (day, mo., yr.)	Priority Claimed under 35 U.S.C. § 119	
			[ ] Yes	[ ] No
			[ ] Yes	[ ] No
			[ ] Yes	[ ] No

5. [X] We hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), § 365(c) of any PCT international application designating the United States of America, and § 119(e) of any United States provisional application(s) that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, § 112, we acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application(s) and the filing date of this application:

Application Serial No.	Filing Date	Status
60/155,052	September 21, 1999	pending

6. We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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1-00

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3-00

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This is the end of the listing of inventors.